

Practice

Converting From Mainframe to Client/Server at Telogy Inc.

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SUMMARY

This paper summarizes many cost-benefit issues addressed by Telogy Inc. in its decision to replace its legacy mainframe computer system with a Client/Server system as a major component of re-engineering the entire organization. Lessons learned are intended to benefit decision makers in assessing the feasibility of migrating their current operations to a Client/Server environment. This paper summarizes what Telogy Inc. experienced during and after conversion of its centralized mainframe computer system to a distributed, Client/Server environment. Issues addressed include reasons for the migration, comparison of mainframe and Client/Server systems, outsourcing, cost-benefit considerations, productivity impact, roles of vendors and users, training, responsibility for data synchronization, and software maintenance. Lessons learned address: (1) overcoming resistance to change, (2) managing user data during conversion, (3) involving users in the migration, and (4) linking migration success with management and employee performance appraisal and compensation.

KEY WORDS: business process re-engineering; legacy information systems; Client/Server processing; systems migration; cost-benefit analysis; maintenance outsourcing

1. CORPORATE PROFILE OF TELOGY

Telogy Inc. is a rapidly growing, privately held electronic test equipment and measurement company. Based in Menlo Park, California, Telogy has approximately 200 employees and derives about half its revenues from outside the United States. The firm buys, sells, refurbishes, rents and manages test and measurement equipment. Its inventory of 5 000 models and 30 000 units of equipment is worth over \$250 million. Customers span several industries, such as computing, data communications, automobile manufacturing, aerospace, pharmaceuticals and financial services. Suppliers include original equipment manufacturing (OEM) companies such as Fluke, Hewlett Packard and Tektronix. Telogy is able to lease equipment back to the equipment manufacturers and thus competes with its suppliers. Competitors include AT&T, Ford and General Electric.

2. SYSTEMS EVALUATION

2.1. Motivation to migrate

In 1991 Telogy realized it needed a computer-based information system that was more flexible and could grow with the firm more easily than the system it was using. Cost-cutting was not the primary motivator. To achieve a competitive edge, Telogy sought to configure, fine-tune, deliver and invoice equipment within 24 hours. To that end, Telogy wanted a streamlined, seamless systems infrastructure that integrated functional areas as sales, marketing, engineering, operations, finance and customer support. Figure 1 shows an overview of the processes Telogy wanted to be supported.

Telogy found its existing system constrained the way the firm wanted to do business. The Hewlett Packard HP-3000 with 'dumb terminals' was implemented in 1984 and was programmed to generate reports 'by the pound.' It ran Turbo-Image, COGNOS software and undocumented source code for applications software mostly in FORTRAN. Telogy had to hire consultants from the software vendor whenever modifications were needed, which proved to be tedious and expensive. Consultants were customizing 'spaghetti' code that had been previously customized without the benefit of good documentation. Every change to the old system created more complexity, requiring months instead of days to make program alterations. The time and complexity involved with modifying the centralized HP-3000-based system constrained company growth and created an unstable systems environment. Furthermore, the system required 12 full-time employees to support it.

2.2. Alternatives and choices

Telogy began migrating to a distributed computer-based information system in 1992 with the goal of project completion within two years. No software package that met all of Telogy's needs was available due to the unique nature of its business. Developing software from scratch internally would meet all of the firm's requirements, but the

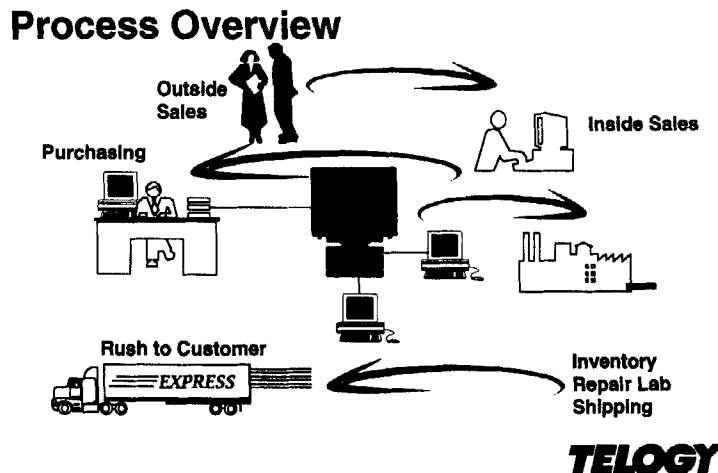


Figure 1. Overview of the Telogy business process

estimated time required was four years at a cost of about \$24 million. That assumed an average staffing of 12 Telogy people and eight independent contractors. The \$24 million estimate for custom development was computed based on the assumption that it would take 100 person years of effort at \$20 000 per month per project member. The \$20 000 per month figure, in addition to labour cost and employee benefits, included other information systems costs, such as purchased software, technical support, networks access and support, and hardware the programmers would need.

Telogy compared customized software development with packaged software. Before making the final decision, various development packages were evaluated. Sybase was compared with Oracle before Telogy decided to purchase Sybase as its underlying relational database management software. Sybase was preferred because of its connectivity capabilities and open systems architecture, which allowed a greater selection of software developed by independent software vendors. After evaluation applications packages against such competitors as Avalon, Telogy proceeded to purchase a customer resource planning (CRP) package from Aurum Software and a manufacturing resource planning package (MRP) from TXbase as the foundation of its systems infrastructure.

Pilot tests showed that these off-the-shelf packages were about a 75 per cent fit for Telogy. Within the CRP package, financial services, renting, leasing, market pricing and cyclic billing, and credit evaluation had to be customized due to the unique nature of Telogy's business. Market pricing is unique in that it is based on broker quotes, similar to those of the New York Stock Exchange. The MRP package had to be customized to accommodate refurbishing and repair (rather than the manufacturing) of testing equipment. Also in need of customization was identification and priority given to items in inventory 'available to promise (ATP)'. Influencing which one of five identical pieces of equipment to commit first are considerations of depreciation and carrying costs. Furthermore, the compatibility of the two main packages from TXbase and Aurum had to be improved, as for example, how to handle the situation in which both packages assigned different data items to the same storage location. Also the CRP and MRP packages needed synchronization in the generation of statistics for commitment fulfillment, because one of Telogy's main goals is to deliver anywhere in the USA within 24 hours.

Once the software decisions were made, Telogy focused on hardware selection. Telogy opted for an open-systems hardware platform because of the flexibility it provides with regard to software available from independent vendors. Based on tests for compatibility with the packaged software selected and evaluation of price performance, reliability, and upward migration capability, UNIX client servers from Sun Microsystems were selected and X-terminals from Network Computing Devices (NCD). Figure 2 shows an overview of the new Client/Server systems architecture. Figures 3 and 4 show an overview summary of the implementation schedule for phases one and two of the migration from the legacy system ('RAM') to TXbase MRP applications software. The timeframe for some modules has changed since these Gantt charts were prepared.

Telogy gained a competitive advantage over its competition by purchasing software packages and implementing them faster than by custom developing similar applications internally. Telogy gained strategic advantage by tailoring these packages to perform tasks its competitors were unable to do. Responsibility for some continual software maintenance accompanies the license of source code. Yet, licensed software may require less maintenance than would internally developed applications. The software package vendor assumes some enhancement (maintenance) responsibility by periodically offering upgrades to prior

Systems Architecture & Integration Challenges

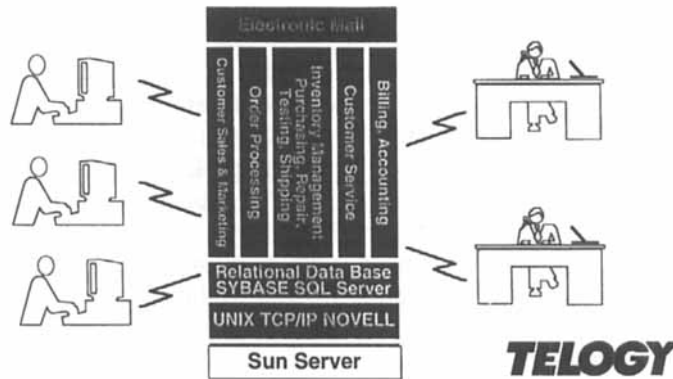


Figure 2. New integrated Client/Server systems architecture

versions of the same application. For this reason, Telogy management expects partnering with the software package vendors to cost less in the long run than internally developed custom applications.

2.3. Phased migration

The Sun Microsystems server was installed in January of 1993. Next, local area networks using Novell Network were installed and tested. The database was installed in February of 1993. By January 1994, the three Aurum CRP modules and six of the 23 TXbase MRP modules were installed. The 23 TXBASE applications are summarized in Table 1.

Telogy did the migration implementation in six phases.

1. Sales and marketing and leasing.
2. Order filling inventory management, refurbishing, shipping and billing.
3. Imaging for equipment and options.
4. Purchasing and sourcing.
5. Supply.
6. Customer chain: vendors and customers.

Figure 5 provides a sample plan for the implementation of the sales and marketing module. User requirements, both original and changes resulting from personnel turnover, have required continual modifications and custom enhancements.

2.4. Systems integration

The seamless infrastructure was developed by integrating 27 application subsystems through common tables and stored procedures, for example, calculation of ATP statistics. The three-tier architecture is composed of multiple servers, application clients and desktop

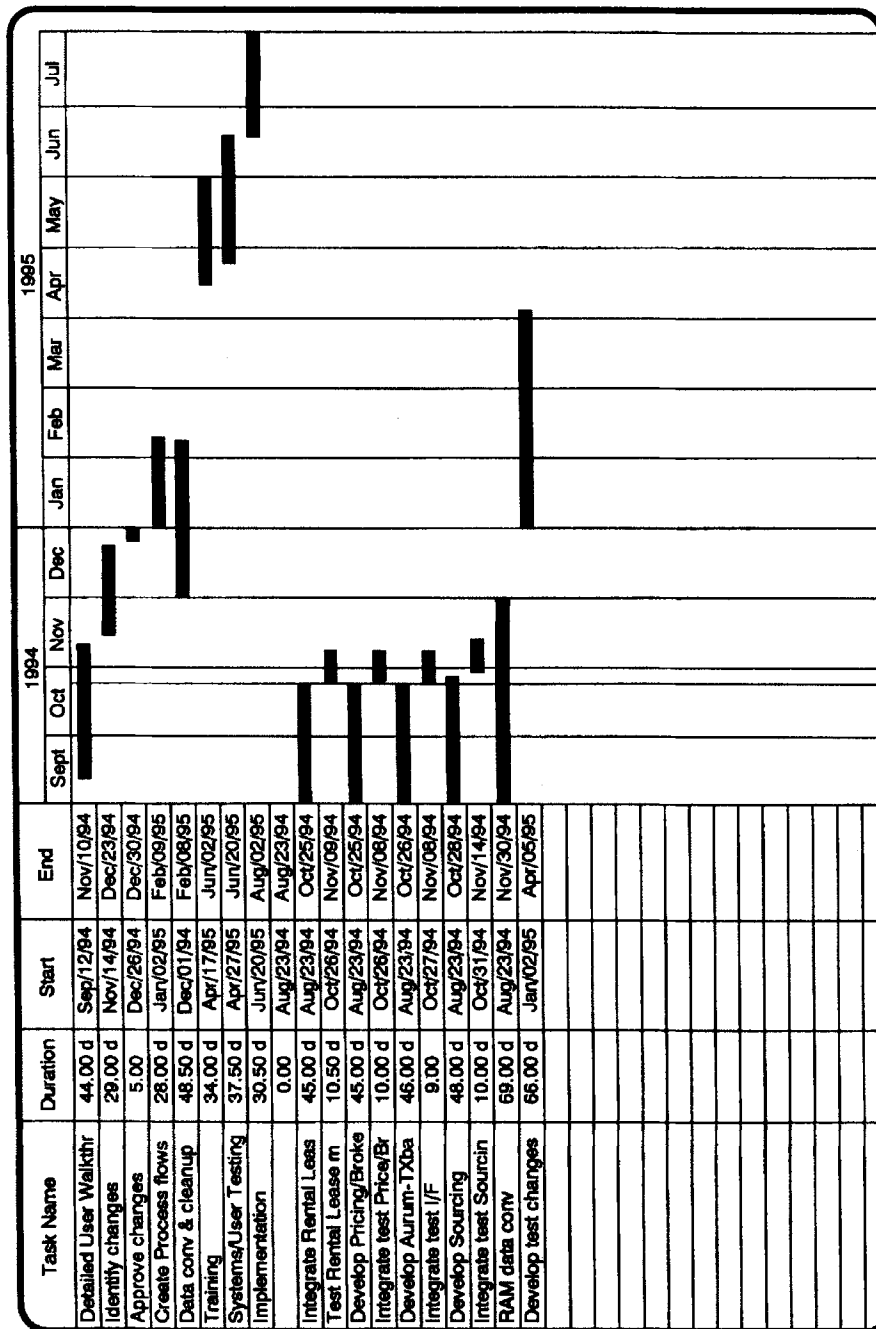


Figure 3. Gantt chart schedule of phase 1 migration implementation

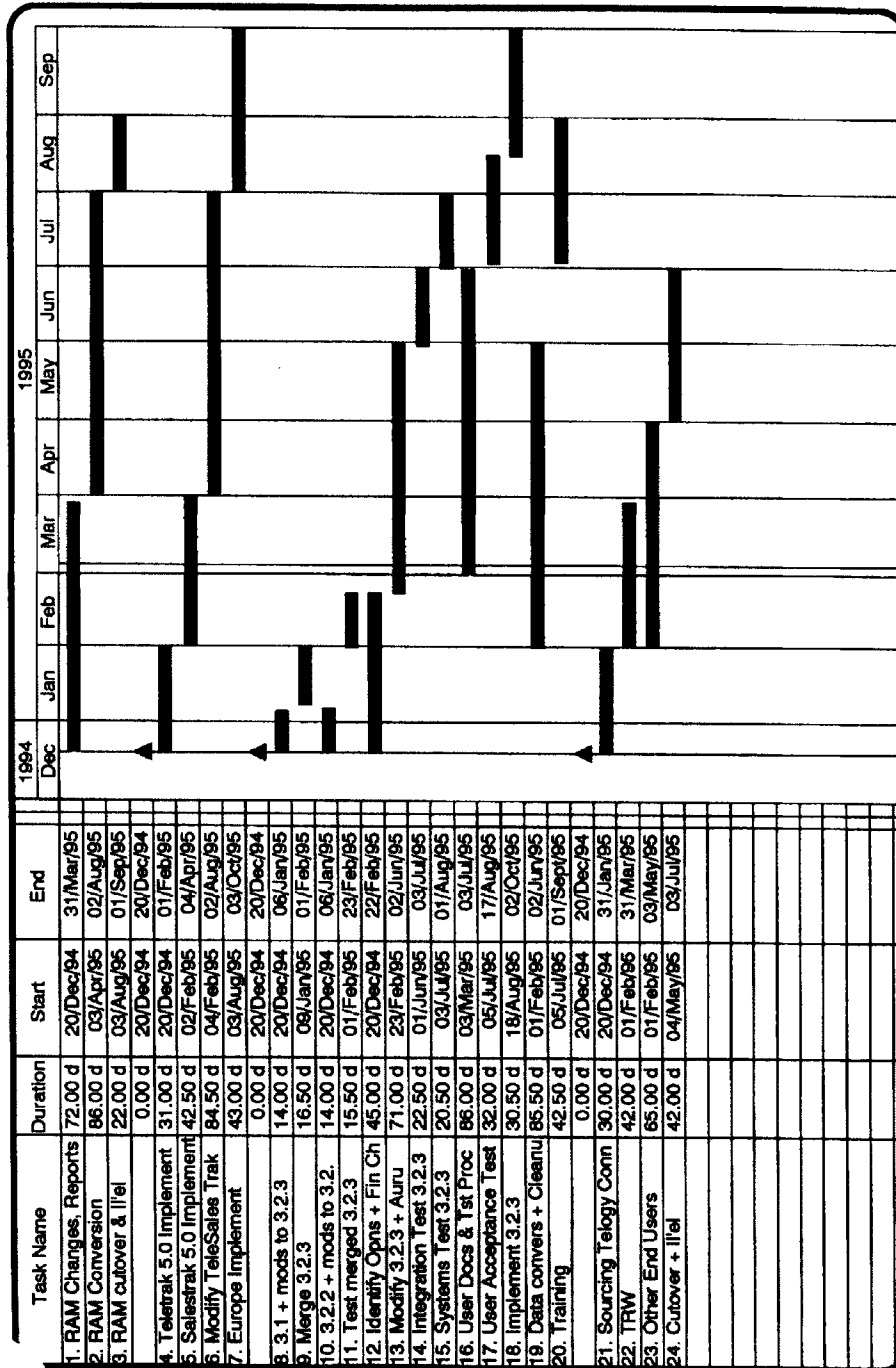


Figure 4. Gantt chart schedule of phase II migration implementation

Table 1. TXbase MRP functions and modules

Asset management	Sourcing international
Catalogue	International requisition
Fixed asset	Capital requisition
Capital authorizations	Partner management
CL\$/TSP/FMV	Broker management
Delivery/available to promise (ATP)	
Product management	Sourcing domestic
Bill of material	Capital requisition
Item master	Partner management
	Broker management
	Auctions
Purchasing	Purchasing MRO
Capital requisition	MRO requisitions
Capital purchase order	MRO purchase orders
Incoming inspection/quality control	Receiving capital/MRO
MRB	
Vendor management	

computers, as mentioned previously. Figure 6 shows a schematic of Local Area Network (LAN) architecture.

Each network has three subnetworks. If a desktop computer fails, there is a back-up available; if a file server fails, there is a back-up because Telogy uses two files servers; the network has redundant hubs, so in the event of a hub failure the other would take over transparent to the user. In sum, each of the three network layers has a back-up. Thus, fault-tolerant computing is accomplished through subnetworks, replication servers, hubs, disk mirroring and tuning for performance. On the rare occasion that the system fails completely, it is back in operation within 15 minutes. Response times are usually subsecond. For the unusual search for one record among 7 000 in a database, it may take five seconds. Furthermore, Telogy acquired a new PBX telephone system that was combined with automatic call distribution to ensure seamless integration between voice and data, enabled by Aurum Teletrack software, and to facilitate efficient handling of customer calls.

2.5. Outsourcing

Intense training of internal computer systems staff, hiring of skilled contract programmers and contracting of software vendor consulting services were all part of the conversion process. Because demand for development staff with Client/Server skills is high, so are the fees they charge. This led Telogy to explore outsourcing.

Telogy's Chief Information Officer (CIO) identified several well-reputed software firms in India that had established offices in the United States. HCL was selected to develop

Sales Implementation plan

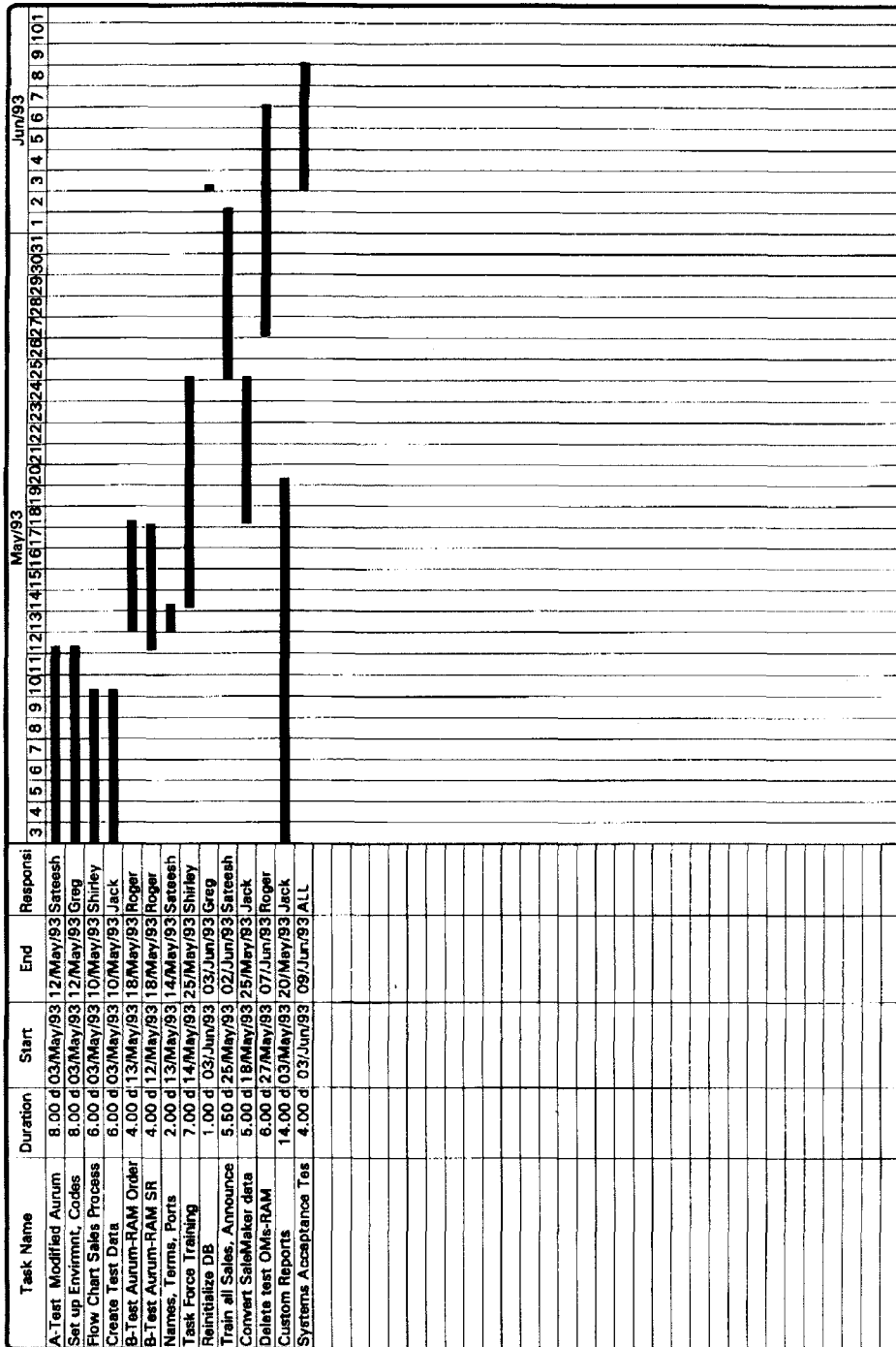


Figure 5. Gantt chart for sales migration implementation plan

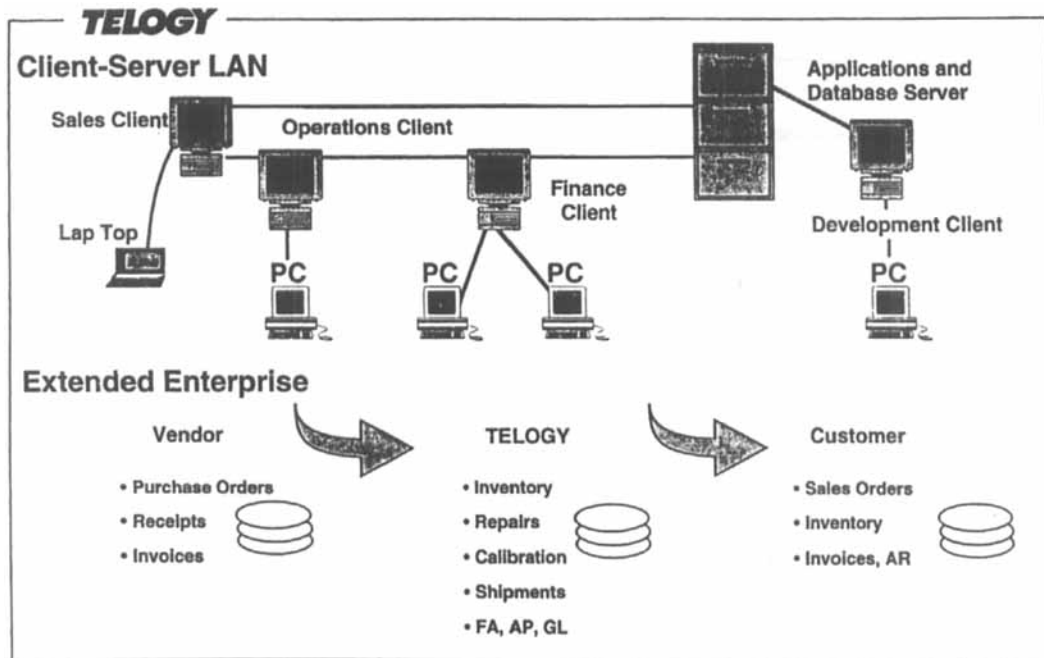


Figure 6. Schematic for Client/Server LAN (local area network)

customized software and facilitate systems integration. HCL staff in India worked jointly with Telogy staff in the US by 'telecommuting' through networks. Because of the 12-hour time difference between the countries, someone was working on the project around the clock. This cut development calendar time to half of initial estimates. Furthermore, HCL provided staff with knowledge base and skill sets superior to those of Telogy employees and charged fees far below what comparable staff would cost in the US (Strehlo, 1994).

The software 'development' included extensive modification of the Aurum and TXbase software to accommodate other modules for processing leasing, equipment management, financing, and billing (Harding, 1994). In sum, application software personnel, database administrators, systems and network administrators, and support staff were presented with a tremendous challenge.

For the first phase of the project, two application designers from HCL worked in California with Telogy. The coding and programming phase was done in India, under the supervision of the application designers who developed the initial design while in the USA. Modules of code were transmitted electronically for testing. The Indian and USA teams held telephone conference calls weekly to co-ordinate efforts. Tables 2 and 3 show by module the TXBASE software customization schedule for HCL. As Telogy transitions from implementation to systems maintenance, 12 people in India support the new system, and they co-ordinate with two persons at Telogy's corporate office in California.

Telogy's 12 staff members who had worked on the legacy system being replaced did not suddenly disappear. Most were gradually retooled either to maintain the new Client/Server system or for other information systems responsibilities. While most of the

Table 2. TXbase software customization schedule by module. Part 1

Function	Man days
Operations/equipment management	
Asset availability (ATP)	20
Cal card history	33
Ship sets/early ships/partial on SO	8
Inventory control for assets/parts	1
<i>Added on 02/10/95</i>	
Positive receipt	10
<i>Added on 03/03/95</i>	
Broker quotes (enhancement to TXbase VENDOR CATALOG function)	3
Process to calculate strategy, utilization, yield enhancement to item masters to store strategy, utilization, yield, ranks, residual grade	8
Asset reserve/unreserve	4
<i>Added on 03/06/95</i>	
Pricing (FMV/TSP/LIST including lookups)	7
Item substitution	2
Assignment of unassigned assets to sales order (assets reserved for order fulfillment)	8
Release of unassigned assets reserved for order fulfillment	2
Order PICKING process to PICK only assigned assets	2
Reservation of asset on receipt to OF if not assigned in advance	2
Work order cost control (financial feasibility of work order repair)	15
	125
Finance	
Provision to stop tax billing if order becomes tax exempt at a later stage	6
Provision to change monthly price/PO ref/territory/terms/salesperson/lookup status on conversions, unsale etc	25
Asset to be printed with invoice line (completed)	0
Automatic credit note generation with rental returns	9
Enter cash receipts at invoice level regardless of customer master (<i>TXbase 4.0</i>)	7
Provision to keep track of credit memo dollar amount distribution to invoices	15
Ability to classify unapplied cash in AR aging	5
Link between Aurum and TXbase must be as seamless as possible (<i>Dropped</i>)	
FLP/OLP catch-up billing	11
Personal property tax amount has to be pro-rated with each cyclic billing	16
Change of ownership of an asset	22

initial software customization was done by the Indian team, most of the systems maintenance has since been gradually transferred to Telogy employees. For the sake of continuity, Telogy retains at least one back-up person offshore who was on the original Indian team.

2.6. Training

Telogy identified training as one of the most important factors to successful migration to the Client/Server systems. A prerequisite to training is documentation. Procedures and

Table 3. TXbase software customization schedule by module. Part 2

<i>Added on Jan 20 1995</i>	
Cyclic invoice—One invoice to be generated for an agreement containing several orders (<i>Dropped</i>)	
Change of customer and SHIP-TO to be allowed irrespective of order status	5
<i>Added on Feb 8 1995</i>	
Agreement no. should be the sales order No for MTM and DS	2
<i>Added on Feb 27 1995</i>	
Business type LTR to be introduced for SOP/invoice/returns	10
	133
Sales/customer support	
Ability to avoid generation of any financial inventory transactions in certain type of rental returns	23
<i>(The above covers exchange/loaner/repair processes & call tracking query module)</i>	
Query history of rental/sold assets	
<i>(The above is covered under finance requirement)</i>	
<i>Added on Mar 13 1995</i>	
Generate debit/credit note at rental returns based on new pricing strategy	8
	31
AURUM-TXbase interface	
Avoid order confirmation for existing CUSTOMERS at TXbase end (awaiting confirmation)	6
Hold ORDERS in staging area for new CUSTOMERS for credit check	1
<i>Added on 03/07/95</i>	
Enhancement of order interface module at TXbase to include add ons/sets/ship partial/modification of quote	???
Enhancement of order interface module at TXbase to include PER/TER/special request (awaiting confirmation)	
Enhancement of order interface module at TXbase to include action flag for ops instead of special comments on order	???
Update AURUM quote with CUSTOMER NO and SHIP TO NO created/updated at TXbase	3
	10
Customization testing	
Test plan	2
Test data generation	2
Unit test and fixes	3
Integrated test and fixes	5
	12

Table 3. Continued

Function
Location of work order
Item summary information
WO creation on used equipment receipt
Provision to print CR/DR notes
Need to report sales and rental dollars by asset number
Provision to query invoices/CM/DM/payments based on transaction type/GL account
Report—differentiating third party vs telogy cash receipts
Must have link between invoices and agreement no.
Work order costing
Report—visibility needed on sales/FLP/margin/cash receipts based on plan/transaction type
AURUM-TXbase integration
Data conversion
TXbase vs RAM data map
Data download scripts on RAM— <i>Telogy MTS</i>
Data upload scripts on Sybase
Integrated testing/analysis of conversion

process flows that existed only in the minds of computer users had to be documented before effective training could occur. It is important to provide incentives to document early. Training proved to be a full-time endeavour for many information systems, user, and human resources personnel. Table 4 presents four phases of the training. A user training matrix shown in Tables 5 and 6 summarizes the number of employees by department, and the vendor training hours requested for them.

Training and documentation for the new Client/Server system were prepared with the additional objective of Telogy's becoming ISO 9000 certified. Combining these processes

Table 4. Telogy training time table

Phase	Trainer	Time period	Content and length
1	Vendors	Analysis and design	Product overview; two two-hour sessions on two days
2	MIS staff	Analysis and design	System modification concepts; half day in length
3	MIS staff	Pre-systems testing	Systems functionality; all day on three non-consecutive days
4	User staff task force members	During conversion (implementation)	Respond to user questions; as needed during first month, by two members per department

resulted in approximately a 50 per cent cost savings normally associated with qualifying for this certification. The savings were achieved by going through such efforts as analysis, synthesis, training, and documentation for both Client/Server system and ISO certification one time instead of two. Thus, Telogy got the benefit of two systems for nearly the price of one. In addition, Telogy improved its competitive position in Europe by becoming ISO 9000 certified.

2.7. New system maintenance

To summarize, the new three-tier Client/Server system consists of back-end database servers, application servers, and client desktop computers. It supports a variety of end-user computers including Sun Sparcstations, PCs, laptops and Network Computing Devices' X terminals. The new system runs the modified CRP from Aurum software and the modified MRP II from TXbase. X-terminals permit users to display multiple windows on the same screen, which enables them to bridge between database systems and the Aurum and TXbase software on the desktop.

Cost savings for the new system were more significant for the software than for the hardware, especially since Telogy chose to license rather than make its software from scratch. The Client/Server based software cost approximately 70 per cent of what the old system cost. Cost saving on the hardware was less dramatic. While Telogy saved about 20 per cent on the hardware, annual company growth of 20 per cent absorbed these savings. Cost overruns eventually absorbed anticipated savings. This was not a major concern, given that competitive advantage was the major motivation to convert to a Client/Server system. This state-of-the-art implementation and functionality calls for continual maintenance. Based on historical experience, frequency of upgrades and changes averages as follows (Lele, 1995):

System	Frequency
Client/Server hardware and Novell network	1 time per week
Desktop computer tools (calendar, notes, etc.)	1 time per month
Aurum CRS and TXbase	3 times per year
Sybase and related tools (Gupta, Unify)	2 times per year
UNIX and PCs/X-terminals	1 time per year
Version control software	1 time per year
PBX, voicemail, auto call distribution	1 time per year

3. BENEFITS EXCEED COSTS

3.1. Costs higher than expected

The costs for the new system were nearly \$4.8 million, compared to the \$4.5 million that was budgeted. Most of the cost overruns are attributed to extensive customization

Table 5. TXbase user training matrix. Part 1

Employees in Department	A/P	Accounting	Accounting services	Asset management	Credit/collect	Customer services
	3	4	6	4	7	5
Modules:		# hours module training requested by department				
Accounts receivable	8	8	16		4	
Aurum/TXbase interface		4				3
Bill of materials						6
Cal card						
Call track					4	
Cash receipts				4		
Configuration master					4	
Credit approval					4	
Customer master					4	
ENG						
Finance administration		8	4			
Fixed assets				2		
Inventory management				4		
Item master				4	4	
Item numbers/configurator						
Item summary screen				1		
Materials			4			
Parts/repairs purchasing	4					
Processing inventory invoices	8					
Purchase order query		4		2		
Purchasing	4					
Receiving	4					8
Repair/return				2		
Requisitions						2
Reshipping R/R					4	6
RMA module		4	4			
Sales						

Sales analysis			
Sales order line comments			
Sales order process setup			
Sales order processing	4		3
Security	4		
Set up materials			
Shop floor control			
Standards maintenance			
Standards used		1	
Vendor catalog			
Work order management			2
Work order requirements			
Work order transfer			

Table 6. TXbase user training matrix. Part 2

Employees in Department	Inside sales	Lab	O.F.	Operations	Remarketing	Sourcing
	18	36	10	19	4	9
Modules:						
Accounts receivable						
Aurum/TXbase interface	8	2				
Bill of materials		1				
Cal card						
Call track						
Cash receipts						
Configuration master						
Credit approval						
Customer master						
ENG	4					
Finance administration	6				1	
Fixed assets						
Inventory management			5	5		
Item master						
Item numbers/configurator		1			1	1
Item summary screen						
Materials	4					
Parts/repairs purchasing						
Processing inventory invoices						
Purchase order query			10	5	1	5
Purchasing						
Receiving						
Repair/return						
Requisitions					1	
Reshipping R/R						
RMA module						
Sales	12					

Sales analysis				2	
Sales order line comments					
Sales order process setup	1			1	
Sales order processing		10		4	
Security					
Set up materials			5		
Shop floor control			5		
Standards maintenance	4				
Standards used	2				
Vendor catalog				1	2,5
Work order management		5	5		
Work order requirements	2				
Work order transfer	1				

(mostly enhancements), turnover among users, and changing requirements of the users. Far more customizing was required than originally anticipated. In spite of this, Telogy substantiates that the following benefits more than justify the costs:

Three-year benefits quantified

Increased net revenue ($20\% \times \$75 \text{ million sales} \times 11\% \text{ profit}$) $\times 3$ years	\$4 950 000
Reduced inventory cost ($15\% \times \$200 \text{ million} \times 15\% \text{ interest}$)	\$4 500 000
Total benefits	\$9 450 000

Three-year costs quantified

Hardware (Clients/Servers, networks, installation, interest)	\$1 100 000
Software (packaged software, contract services, interest)	\$1 200 000
Training and conversion (including internal costs ¹)	\$ 600 000
Operating costs over 3 years	\$1 900 000
Total costs	\$4 800 000

Three-year benefit/cost ratio² = $\$9.45 \text{ million} / \$5.8 \text{ million} = 197\%$

¹Conversion costs include the opportunity cost of what Telogy employees did not do while in training for the new system.

²Auditors have calculated the return on investment to exceed 200%.

Despite the happy ending, costs far exceeded the original estimates. Early estimates for hardware costs were about \$1 000 000 whereas actual was about \$1 100 000, about 10 per cent over original estimates. Early estimates of software costs were about \$1 000 000 whereas actual costs were about \$1 200 000, about 20 per cent over original estimates. Fortunately, cost saving was not the main reason Telogy converted to a Client/Server environment!

3.2. Sales, marketing and leasing benefits

Using the Client/Server system, inside and outside sales teams and telemarketers can work together to determine customer needs, provide quotes, and close orders faster. This is achieved through server-compatible notebook computers for uploading and downloading information in a shared database. Order cycle time has been substantially reduced. Customer 'hand-offs' between outside and inside sales personnel have been eliminated. Sales have increased by 20 per cent as a result of improved responsiveness to customers. Sales personnel now have less paperwork and more time to devote to customer contact. They are also able to identify and target potential customers more readily, resulting in more sales with less effort. Furthermore, since Telogy also markets via the Internet, customers can order electronically. All these improvements build global competitive advantage for Telogy (Campanelli, 1995).

The new Telogy Leasing Card based on customer financial information was issued to

hundreds of customers. This generated 9 per cent more net leasing revenue by simplifying credit approval and the processing of customer orders.

3.3. Orders, inventory, shipping and billing benefits

Using the stored trigger features of Sybase, Telogy customized both the Aurum CRP and TXbase MRP so that exception conditions can be detected immediately and triggers activated to initiate electronic mail messages to designated persons in functional areas. Examples of exceptions include big orders, low stock, bad customer credit, and overdue deliveries. Direct benefits of this subsystem include reducing the billing cycle time to two days from 11 days. On time deliveries increased from 66 per cent to 85 per cent, approaching Telogy's goal of filling 90 per cent of all orders within 24 hours (Santosus, 1994). In addition, without increasing staff, the accuracy of transaction data entry was improved by interfacing with bar code readers.

3.4. Imaging benefits

By using an imaging system, the precise configuration of equipment shipped to a customer can be recorded and a photocopy enclosed with shipping documents to the customer. When the unit is returned at the end of a rental or lease period, the system displays the image and highlights missing accessories. This enables Telogy's finance department to recover promptly missing items from the customer or bill for them. This reduced the variances in the physical inventory count from two per cent to less than half of one percent. Furthermore, the net cost of replacement options was reduced by 12 per cent.

3.5. Purchasing and sourcing benefits

On a real-time basis Telogy needs to identify sources of and obtain equipment from suppliers of electronic test and measurement equipment. The new automated facsimile (FAX) system frees sourcing and purchasing specialists from making telephone calls and manual data entry. Furthermore, through the interactive voice response system, external brokers can enter their price and availability directly into Telogy's database in response to quote requests. This system speeds their locating equipment. In addition, it reduces total procurement costs by six per cent and helps to reduce the order-to-billing-cycle time.

3.6. Vendor and customer link benefits

Through an efficient and effective communication interface with its vendors and customers, Telogy is able to save time regarding ordering, confirming, assigning, picking, packing, shipping and recording accounts payable and general ledger transactions. Furthermore, this system enables Telogy electronically to access customer equipment pools and to fill orders from other customers by drop-shipping equipment directly out of customer equipment pools. This generates revenue for the pool customers and a management fee for Telogy.

3.7. Customer service benefits

The integration of voice (PBX) and data (UNIX-based) through interactive voice response (IVR) permits customers to retrieve data about pending orders. This is available 24 hours a day through a synthesized voice, thus improving customer service without adding staff. The banking industry is renowned for offering customers 24-hour access to account balances through automated voice response systems. However, such a multimedia capability and 24-hour access to order information is unusual for a manufacturing/finance firm such as Telogy. Without increasing operating costs, Telogy has used information technology to improve customer service.

3.8. Productivity software benefits

Office productivity software facilitates sharing of information and helps to break down functional barriers. This includes such applications as Lotus Notes, electronic mail, WordPerfect, calendar manager and calculators. This productivity software on networks is a contrast to the former stand-alone personal computers with multiple versions of software that had to be installed and supported, and in some cases, were incompatible with the new network. Prior to the conversion, Telogy had about 200 stand-alone desktop computers, each with an average of \$2000 worth of software installed, making the total software investment approximately \$400 000. License of comparable software on a Client/Server network costs Telogy around \$50 000. Software providers offer financial incentives for organizations to choose network-based software because this helps to assure compliance with software copyright laws. Customers of these providers, such as Telogy, also benefit from quantity discounts on software license fees. Furthermore, standardization reduced the number of problems caused by software incompatibility and complex technical support. Back-up and security also have been streamlined.

Groupware enables seamless interconnection of global operations with USA operations since file servers all run the same standardized groupware applications through wide-area networks. This provides Telogy with a competitive advantage of speed and flexibility in serving customers globally.

3.9. Executive information benefits

Executive Information Systems (EIS) provide key indicators to senior management to measure the pulse of the company. EIS systems were developed in-house using the APT language developed by Sybase. The main output is an impressive one-page daily report which shows sales information, including rent, lease and billing rate. Also included are repair and inventory statistics, order backlog, on-time deliveries, sourcing, and phone call volume, both incoming and outgoing.

Senior management and department heads using 'Easy Sequel Report Writer' (EZ SQR) software, a report writer developed by Sybase, can access additional vital signs of the company by initiating on-line *ad hoc* queries from their desktop computers.

3.10. Summary of benefits versus costs

In sum, the new Client/Server system has helped Telogy to achieve the lowest cost of operations in the industry and one of the highest revenue-per-employee ratios in the

business world and an annual profit of 33 per cent in recent years. Telogy also enjoys a 25 per cent annual growth rate in revenue and profit in a market growing at five per cent per year. Measured in units, Telogy's shipments have increased by 30 per cent annually. During the same time period the Telogy headcount has increased about 10 per cent. Even though the new Client/Server system costs more than the previous centralized one, it is reasonable to conclude that the benefits exceed the costs. This feat could not have been achieved without strong support from top management. Telogy's Chief Executive Officer (CEO) and CIO formed a solid partnership to manage radical changes in the organization, its culture, its processes and its systems.

Telogy benchmarked itself against industry data. A cost of operations comparison was done by reviewing 10-K reports and other information available about publicly held companies such as Hewlett-Packard, General Electric, John Fluke, AT&T and other firms competing with Telogy, and then comparing the results with Telogy's costs. A revenue per employee comparison was made by using the special April 1995 issue of the *San Jose Mercury News* and extracting total revenues and total employees for silicon valley companies in businesses similar to Telogy in order to calculate revenue per employee. The results were approximately \$330 000 per full-time equivalent employee per year for these firms, compared with over \$400 000 for Telogy.

4. ROLE OF THE VENDORS

Hardware and software vendors had a significant role during the conversion. They were constantly fixing bugs and customizing the software. The tendency was for the vendors to blame the problems on other vendors. Occasionally Telogy had to get the vendors together in the same room and 'knock heads together' until they got the system working. Vendors also provided training on their products.

5. ROLE OF USERS

Initially users resisted change, perhaps because it entailed substantial re-engineering including likely changes in the roles of Telogy employees. This created fear about loss of job, self worth and status. Over time, users bonded together as though they were war buddies.

Early in the project users became involved by appointing two representatives from each of seven departments to the task force. These two representatives served as MIS liaisons for their departments and later helped to train and support other users in their department. This helped to facilitate user involvement and their gradually buying into the new system.

User training and involvement are important throughout the project and help to reduce resistance to change. In the case of Telogy, too many users lacked involvement and interest until it was time to make the actual conversion. The need for considerable amounts of training and handholding even after migration was the consequence of resistance to change until it obviously was inevitable.

Rapid deliveries of modules in a phased delivery are important, for example, at least one application module every three months. Otherwise users have too much time to think about the system and their expectations increase. This in turn leads to change requests before the system is even implemented, adding to delays and increased costs. Even though Telogy averaged an installation of one new module every three months, users began

making change requests before the new system was fully implemented. Some change requests were proposed on a whim, for example, 'I bet the system could do ... (the following).' Rapid implementation helps to keep the organization focused on using the new system rather than on changing the original requirements, specifications and expectations.

6. LESSONS LEARNED

6.1. Anticipate resistance

Facilitated by the Client/Server network, Telogy has restructured its organization in order to eliminate some layers of management, resulting in much flattening of the organizational pyramid. Initially users of the system had difficulty crossing functional and technical boundaries. For example, an employee in Telogy's refurbishing/repair department did not understand the need to *persuade* accounting personnel to do something. It is important to anticipate resistance to change and address it early. It also is important to find ways to cross functional barriers with ease in the organization, which may in turn reveal unexpected benefits of co-operation and understanding.

6.2. Involve a data administrator

The islands of automation that existed under the old system had to be converted and consolidated. Telogy appointed a data administrator to take responsibility for data conversion, reconciliation and synchronization early on in any conversion. The database administrator on staff was involved in technical aspects of the conversion more than in data integrity issues. Issues of data element names, data ownership, who authorizes update versus read only, and other relationships are best resolved near the beginning. Otherwise drastic actions during conversion, or even after implementation, may be necessary.

6.3. Get users involved

User involvement should be constant from the time of specifications through implementation in order to minimize resistance to change and to assure success of the project. In the case of Telogy, users were involved early on but should have been even more so. Two persons from each of seven departments comprised the 14 member task force. Usual attendance at meetings was 10 to 12 users. These departmental representatives led their department through the conversion. They decided what changes, testing and training were needed. They also did much of the training. If Telogy had to do it over again, Telogy would insist on a minimum of three, or preferably four, user representatives from each department on the task force. This would also facilitate user training at an accelerated rate.

6.4. Secure management buy-in at all levels

Users must accept responsibility for the new system from the beginning. User interest in the project can be sustained through good communication, recognition for good ideas, praise and training. Incorporating 'success of implementation' into performance appraisals and compensation facilitates co-operation. Gaining proactive support of the CEO and

senior management is imperative. At executive levels it is especially important to defuse territorial battles. One way to encourage the success of the re-engineered process and new technology is to weight it heavily in the executive compensation incentive package (Duncan, 1991). Senior managers at Telogy, for example, the Chief Financial Officer (CFO), have specific objectives against which they are evaluated and compensated as part of their performance appraisal. These objectives include successful implementation of the Client/Server system in their areas of responsibility. The CEO was the champion of the Client/Server system at Telogy from the beginning. The CEO weighted heavily objectives pertaining to the re-engineering process and Client/Server system migration in the performance evaluation and compensation process to help ensure motivation directed toward successful completion of Telogy's migration to Client/Server.

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